Cloud Computing

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System of Systems Practice (SoSP) Initiative

SEI Webinar
November 12, 2009

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
12 NOV 2009		**00-00-2009 to 00-00-2009**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Cloud Computing	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Carnegie Mellon University,Software Engineering Institute,Pittsburgh,PA,15213**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**31**	

Polling Question 1

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Agenda

Cloud Computing Defined

Types of Cloud

Drivers for Cloud Computing Adoption

Barriers to Cloud Computing

Relationship to Other Technologies

Summary

Polling Question 2

Has your organization adopted cloud computing?

- No
- No, but we have plans to do so
- Just starting
- Yes

Cloud Computing

"A large-scale distributed computing paradigm that is driven by economies of scale, in which a pool of abstracted, virtualized, dynamically-scalable, managed computing power, storage, platforms, and services are delivered on demand to external customers over the Internet." [1]

Cloud Computing is a distributed computing paradigm that focuses on providing a wide range of users with distributed access to virtualized hardware and/or software infrastructure over the Internet.

[1] I. Foster, Y. Zhau, R. Ioan, and S. Lu. "Cloud Computing and Grid Computing : 360-Degree Compared." Grid Computing Environments Workshop, 2008.

Cloud Computing — Core Concepts

Distributed computing paradigm

- Large-scale distributed system

Resource-based and service-based

- Provides access to a resource and/or service

Elastic and on demand

- Has the ability to scale up or down based on demand

Economies of scale

- Contains a large number of nodes and therefore reduces the overall cost of resource acquisition and operation

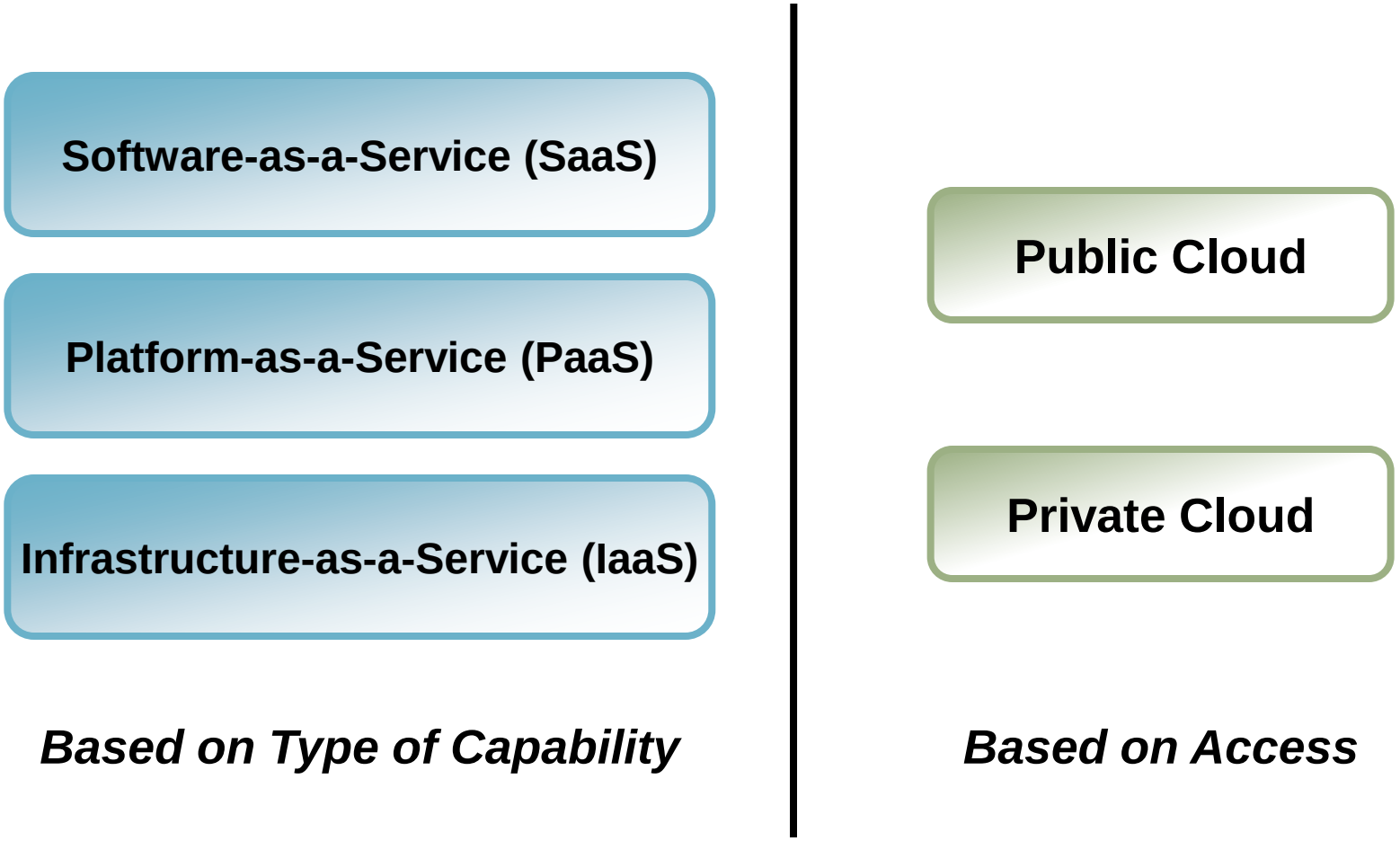
Utility payment models

- Based on pay-per-use model

Based on existing technologies

- Leverages existing technologies such as virtualization, service-orientation and grid computing

Cloud Computing Types



Infrastructure-as-a-Service (IaaS)

Generic computational infrastructure available over the Internet, e.g. compute, storage, etc.

Allows organizations and developers to extend their IT infrastructure on an on-demand basis

Examples

- Amazon Elastic Compute Cloud (EC2)
  - Provides users with a special virtual machine (AMI) that can be deployed and run on the EC2 infrastructure
- Amazon Simple Storage Solution (S3)
  - Provides users with access to dynamically scalable storage resources
- IBM Computing on Demand (CoD)
  - Provides users with access to highly configurable servers plus value-added services such as data storage
- Microsoft Live Mesh
  - Provides users with access to a distributed file system; targeted at individual use

Platform-as-a-Service (PaaS)

Application development platforms, e.g. containers to host Java components

Allows developers to leverage the resources of established organizations to create and host applications of a larger scale than an individual or small business would be able to handle

Examples

- Google App Engine
  - Provides users a complete development stack and allows them to run their applications on Google's infrastructure
- Yahoo! Open Strategy (Y!OS)
  - Provides users with a means of developing web applications on top of the existing Yahoo! platform, and in doing so leveraging a significant portion of the Yahoo! resources
- Akamai EdgePlatform
  - Provides a large distributed computing platform on which organizations can deploy their web applications; large focus on analysis and monitoring
- Microsoft Azure Services Platform
  - Provides users with on-demand compute and storage services as well as a development platform based on Windows Azure

Software-as-a-Service (SaaS)

Application-specific capabilities, e.g., service that provides customer management

Allows organizations and developers to use business-specific capabilities developed by third parties

Examples

- Force.com
  - From salesforce.com (SaaS leader), provides enterprise users a platform to build and run applications and components bought from AppExchange or custom applications
- Zoho
  - Provides a large suite of web-based applications, mostly for enterprise use

Cloud Computing Types — Based on Access

Public

- Offered as a service, usually over an Internet connection
- Typically charge a monthly usage fee
- Users can scale on-demand and do not need to purchase hardware
- Service providers manage the infrastructure and pool resources into capacity required by consumers

Private

- Deployed inside the firewall and managed by the user organization
- User organization owns the software and hardware running in the cloud
- User organization manages the cloud and provides cloud resources
- Resources typically not shared outside the organization and full control is retained by the organization

Development Tools for the Cloud Provider

3tera

- Provides developers with tools to build their own cloud computing infrastructures

Eucalyptus Systems

- Provides an open-source application that can be used to implement a cloud computing environment on a datacenter
- Trying to establish an open set of standards for cloud computing

Polling Question 3

In your opinion, what is the main driver for Cloud Computing adoption?

- Reduced costs
- Reduced risk
- Higher scalability
- Other
- Don’t Know

Drivers for Cloud Computing Adoption

Scalability	Users have access to a large amount of resources that scale based on user demand
Elasticity	The environment transparently manages a user's resource utilization based on dynamically changing needs
Virtualization	Each user has a single view of the available resources, independently of how they are arranged in terms of physical devices
Cost	The pay-per-usage model allows an organization to only pay for the resources they need with basically no investment in the physical resources available in the cloud. There are no infrastructure maintenance or upgrade costs
Mobility	Users have the ability for the user to access data and applications from around the globe
Collaboration	Users are starting to see the cloud as a way to work simultaneously on common data and information
Risk Reduction	Users can use the cloud to test ideas and concepts before making major investments in technology

Polling Question 4

In your opinion, what is the main barrier to cloud computing adoption?

- Security
- Lack of control
- Reliability
- Performance
- Other

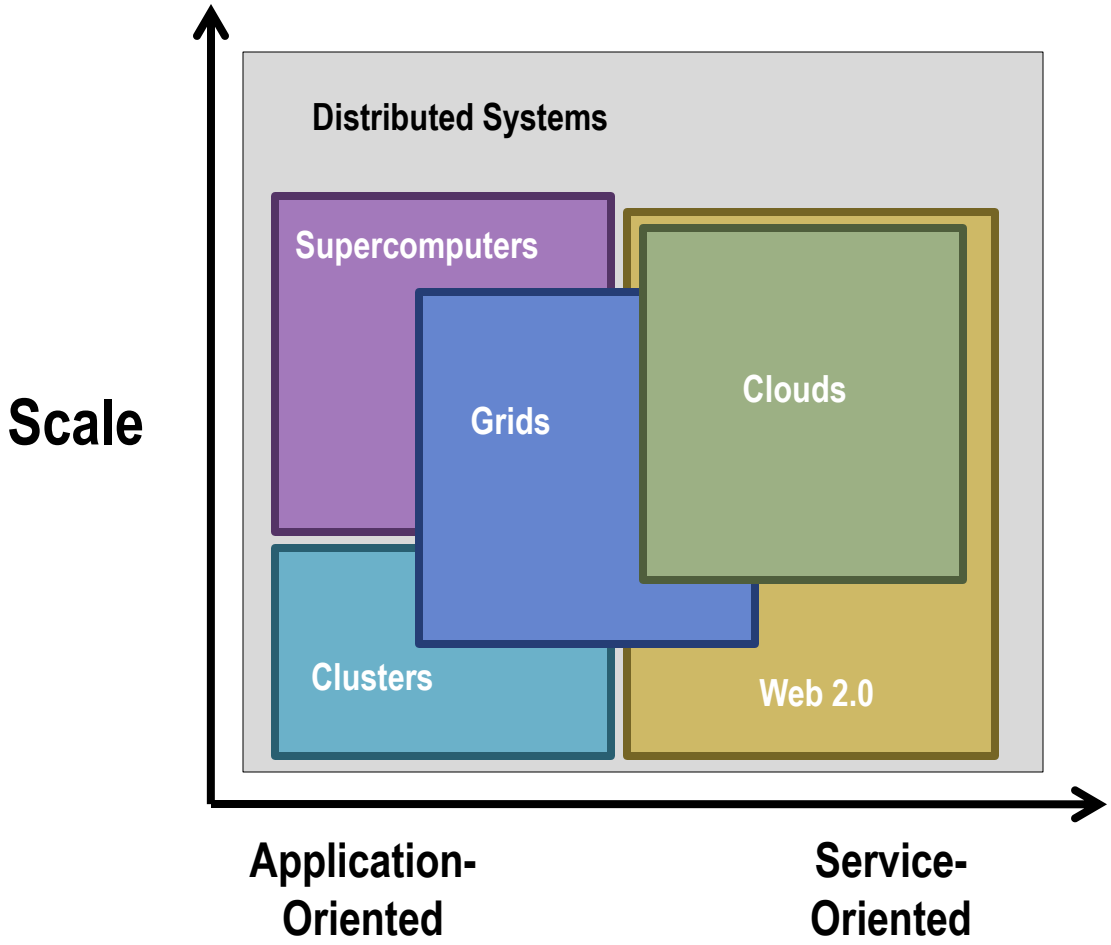
Barriers for Cloud Computing Adoption

Security	The key concern is data privacy: users do not have control of or know where their data is being stored
Interoperability	A universal set of standards and/or interfaces have not yet been defined, resulting in a significant risk of vendor lock-in
Control	The amount of control that the user has over the cloud environment varies greatly
Performance	All access to the cloud is done via the internet, introducing latency into every communication between the user and the environment
Reliability	Many existing cloud infrastructures leverage commodity hardware that is known to fail unexpectedly
Platform or Language Specificity	Some cloud environments provide support for specific platforms and languages only

Other Criteria for Cloud Computing Adoption

Feedback	The ability for the user to obtain the statistics on usage levels
Usability	The ease with which the user is able to configure and operate virtual resources

Relationship to Other Technologies



Source: I. Foster, Y. Zhau, R. Ioan, and S. Lu. "Cloud Computing and Grid Computing : 360-Degree Compared." Grid Computing Environments Workshop, 2008.

Relationship to Other Technologies: Service-Oriented Architecture

Service-oriented architecture (SOA)

- A way of designing, developing, deploying, and managing systems characterized by coarse-grained services that represent reusable functionality
- Service consumers compose applications or systems using the functionality provided by these services through standard interfaces.

The services in a cloud can be defined as services in a SOA context.

- As an example, some of the cloud environments presented earlier offer web service interfaces to their services (one specific implementation of SOA)

From an architectural perspective

- A cloud infrastructure could be built on top on an SOA infrastructure by adding a layer or virtualization and self-provisioning
- A service layer could be added on top of cloud resources
- Some even consider SOA adoption a pre-requisite for cloud computing

Relationship to Other Technologies: Software as a Service (SaaS)

Model of software deployment in which a provider licenses an application to customers for use as a service on demand

Multiple Levels

- Level 1: An application is specifically run for one customer at an SaaS provider, similar to the traditional ASP (application server provider) model
- Level 2: The SaaS application is customizable via configuration and one instance of the application serves only one customer.
- Level 3: The SaaS application is customizable and a single instance of the SaaS application serves multiple tenants.
- Level 4: The SaaS application is developed as a single instance multi-tenant application and several instances are run in a load-balanced server farm.

Levels 3 and 4 of SaaS fall under the definition of cloud computing.

[3] F. Chong and G. Carraro. Building Distributed Applications Architecture Strategies for Catching the Long Tail. MSDN architecture center, http://msdn2.microsoft.com/enus/library/aa479069.aspx, 2006.

Relationship to Other Technologies: Grid Computing

A grid is “a system that uses open, general-purpose protocols to federate distributed resources and to deliver better-than-best-effort qualities of service”[1]

Although the distinction with cloud computing is not clear, one differentiator is that grid computing relates exclusively to infrastructure services

- A grid infrastructure provides a set of abstractions and interfaces for access to, and management of, shared resources

Related terms: utility computing, on-demand computing

[1] Foster, I. 2002. What is the grid? A three-point checklist; http://www-fp.mcs.anl.gov/~foster/Articles/WhatIsTheGrid.pdf
[2] Foster, I., Kesselman, C., Nick, J.M., and Tuecke, S. Grid services for distributed systems integration. IEEE Computer 35 (6): 37-46.

Summary

Cloud Computing is in essence an **economic model**

- It is a different way to acquire and manage IT resources

There are multiple cloud providers—**the cloud is real**

- Currently most cloud consumers are small enterprises
- Large enterprises are exploring private clouds
- The number of providers will most probably grow as people start seeing greater savings and work to reduce adoption barriers

Cloud Computing adoption requires **cost/benefit/risk analysis** to determine

- What resources to move to the cloud (if any)
- What situations warrant use of cloud resources, even for one-time situations
- Implementation of private clouds vs. usage of public clouds
- What risks are associated with using resources on the cloud

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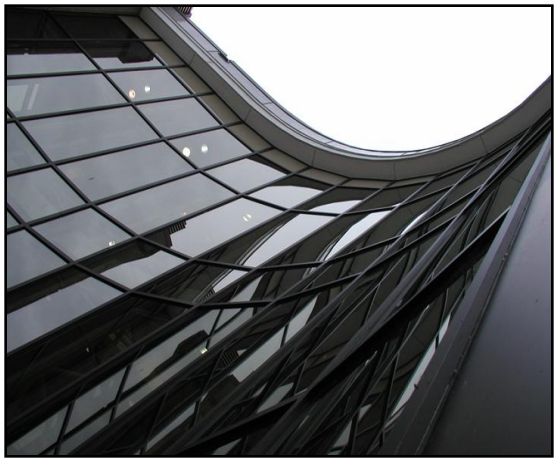

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- Google App Engine: http://code.google.com/appengine/
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